Physics 3204

Course Overview

Unit 1: Force, Motion, and Energy
1.1 - Projectile Motion
1.2 – Dynamics Extension
1 .3 – Circular Motion
1.4 – Equilibrium & Torque

Unit 2: Fields
2.1 – Electrostatics
2.2 – Current Electricity
2.3 – Electromagnetic Induction

Unit 3: Matter Energy Interface
3.1 – Modern Physics
3.2 – Nuclear Physics

Recall:

Equation for Uniform Motion

$$v = \frac{d}{t}$$

Equations for Uniform Acceleration

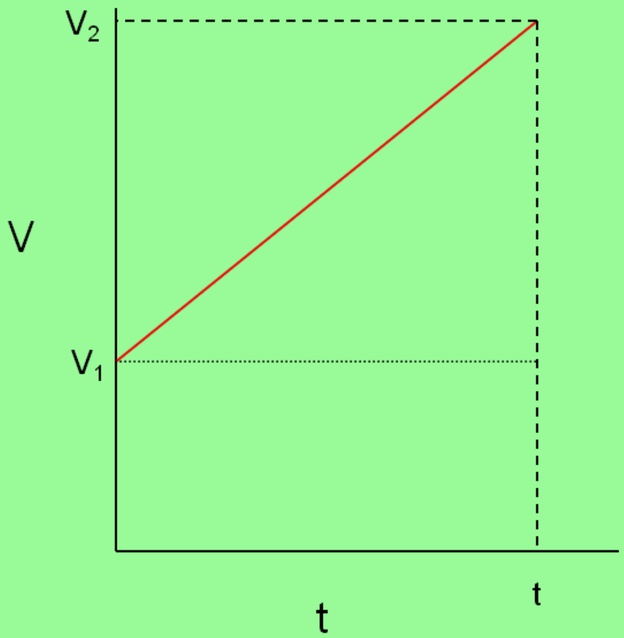
$$a = \frac{v_2 - v_1}{t}$$

$$d = v_1 t + \frac{1}{2} a t^2$$

$$d = v_2 t - \frac{1}{2} a t^2$$

$$d = \left(\frac{v_1 + v_2}{2}\right) t$$

$$v_2^2 = v_1^2 + 2ad$$



$$2ad = V_2^2 - V_1^2$$

1. A ball is thrown upward from atop a 100.0 m cliff with an initial speed of 20.0 m/s. How long will the ball take to reach its highest height? What height will that be?

$V_1 = 20.0\,m/s$

$a = -9.8\,m/s^2$

$V_2 = 0$

$t = ?$

$d = ?$

$$t = \frac{V_2 - V_1}{a}$$

$$t = \frac{0 - 20.0\,m/s}{-9.8\,m/s^2}$$

$$t = 2.0\,s$$

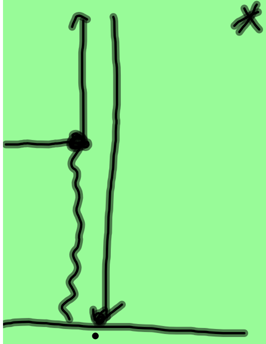
$$d = \frac{V_2^2 - V_1^2}{2a}$$

$$d = \frac{0 - (20.0\,m/s)^2}{2(-9.8\,m/s^2)}$$

$d = 2.0 \times 10^1\,m$ relative to the top of cliff

Or 120 m relative to the ground.

2. For the same scenario, how long will the ball take to fall to the canyon floor, <u>100.0 m below</u> the position from which it was thrown? How fast would it be traveling at that time?



* $d = -100.0\,m$
  $V_1 = 20.0\,m/s$
  $a = -9.8\,m/s^2$
  $t = ?$
  $V_2 = ?$

$2ad = V_2^2 - V_1^2$

$V_2^2 = V_1^2 + 2ad$

$V_2^2 = (20\,m/s)^2 + 2(-9.8\,m/s^2)(-100\,m)$

$V_2^2 = 2360\,m^2/s^2$

* $V_2 = \pm 48.6\,m/s$ Ans: $-49\,m/s$

$t = \frac{V_2 - V_1}{a} = \frac{-49\,m/s - 20\,m/s}{-9.8\,m/s^2} = 7.0\,s$

3. Starting from rest an airplane accelerates and takes off at 175 km/hr. From the instant of first movement to take-off a passenger notices that the second hand on her watch sweeps out 32.0 s. What is the minimum length of runway required?

$V_1 = 0$

$V_2 = 175\ km/h = 48.6\ m/s$

$t = 32.0\ s$

$d = ?$

$$d = \left(\frac{V_1 + V_2}{2}\right)t$$

$$d = \left(\frac{0 + 48.6\ m/s}{2}\right)(32.0\ s)$$

$$d = 778\ m$$

4. Another plane is already traveling at a speed of 11.0 km/h as it enters a runway stretch and requires a distance of 1.22 km to take off if an acceleration of 1.60 m/s^2 is maintained. Determine the time required to take-off.

$V_1 = 11.0\ \text{km/h} = 3.06\ \text{m/s}$

$d = 1.22\ \text{km} = 1220\ \text{m}$

$a = 1.60\ \text{m/s}^2$

$t = ?$

$$V_2^2 = V_1^2 + 2ad$$

$$= (3.06\ \text{m/s})^2 + 2(1.6\ \text{m/s}^2)(1220\ \text{m})$$

$$V_2 = 62.6\ \text{m/s}$$

$$t = \frac{V_2 - V_1}{a} = \frac{62.6\ \text{m/s} - 3.06\ \text{m/s}}{1.60\ \text{m/s}^2}$$

$$t = 37.2\ \text{s}$$

5. Due to many years at sea the starboard and port light supports on the fishing vessel "Physics II" have become quite rusty. On one dark and stormy night the starboard light lets go and falls straight down from its original position on a cross-arm that sits 8.5 m above the deck. (assume that the boat does not rock while the lamp is falling!).

a) How long does it take the light to crash onto the deck?

$d = -8.5\,m$

$V_1 = 0$

$a = -9.8\,m/s^2$

$t = ?$

$V_2 =$

$d = \cancel{V_1 t} + \frac{1}{2}at^2$

$d = \frac{1}{2}at^2$

$2d = at^2$

$\sqrt{\frac{2d}{a}} = t$

$\sqrt{\frac{2(-8.5\,m)}{-9.8\,m/s^2}} = t$

$1.3\,s = t$

b) With what speed does it crash?

$V_2 = V_1 + at$

$= (-9.8\,m/s^2)(1.3\,s)$

$= -13\,m/s$

c) The unfortunate (or maybe we should say fortunate) captain, who is 1.7 m tall, sees the lamp whiz past his eyes on its way to the deck. What fraction of the time of fall had then elapsed?

$t = ?$

$d = -6.8\,m \quad (8.5\,m - 1.7\,m)$

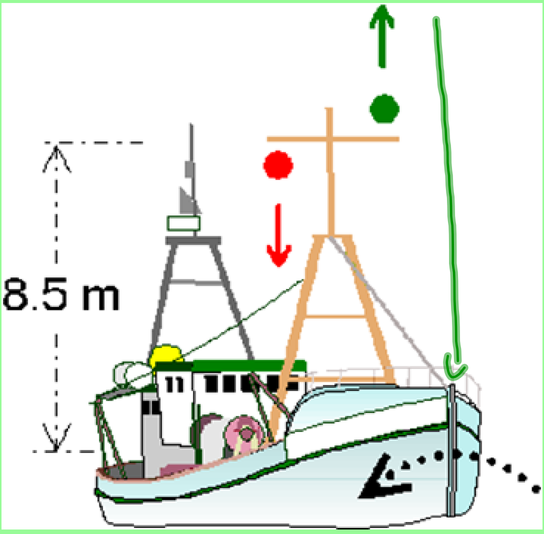
$a = -9.8\,m/s^2$

$V_1 = 0$

$$t = \sqrt{\frac{2d}{a}} = \sqrt{\frac{2(-6.8\,m)}{-9.8\,m/s^2}} = 1.2\,s$$

fraction of time $= \frac{1.2\,s}{1.3\,s} = 0.92$ or 92%

6. Before the next voyage out the captain makes sure that a crew member repairs and replaces the starboard lamp. However, the job was poorly done and, during a heavy roll, not just one, but both starboard and port lights let go. This happens just as the cross arm is coming back to the horizontal so that the starboard light is flung downwards while the port light is flung upwards (see picture). The lamps leave their supports with identical initial speeds of 1.8 m/s but in opposite directions. The captain is having a drop of grog in his cabin when he hears the first light hit the deck. How much time elapses before he hears the second crash?



P(1)	S(2)
$v_1 = -1.8 m/s$	$v_1 = 1.8 m/s$
$a = -9.8 m/s^2$	$a = -9.8 m/s^2$
$d = -8.5 m$	$d = -8.5 m$
$t = ?$	$t = ?$
$v_2 = ?$	$v_2 = ?$

Port(1) & Starboard(2)

$v_2^2 = v_1^2 + 2ad$

$v_2^2 = (-1.8 m/s)^2 + 2(-9.8 m/s^2)(-8.5 m)$

$v_2 = \pm 13 m/s = -13 m/s$

Port(1)

$t = \frac{v_2 - v_1}{a}$

$= \frac{-13 m/s - (-1.8 m/s)}{-9.8 m/s^2}$

$= 1.1 s$

Starboard(2)

$t = \frac{v_2 - v_1}{a}$

$t = \frac{-13 m/s - 1.8 m/s}{-9.8 m/s^2}$

$t = 1.5 s$

$\Delta t = 0.40 s$